

Frugal Innovation and Core Characteristics: A Systematic Literature Review

Y.L.Velananda

Doctoral Researcher, University of Kelaniya, Sri Lanka

D.M.R. Dissanayake

Professor, University of Kelaniya, Sri Lanka

C. N. Wickramasinghe

Professor, University of Kelaniya, Sri Lanka

Abstract

Making products that cater to the requirements of emerging and new markets may help businesses all around the world. The concept of frugal innovation has resulted in many successful products for various markets that save money, focus on the most critical aspects, and perform well. According to the literature study, organizations must have a frugal mindset to come up with frugal innovations. For this qualitative study, the SPIDER methodology was employed. Businesses must learn to think frugally to come up with innovative ideas on a limited budget. A comprehensive review of the literature was undertaken to identify the most important aspects influencing people's decisions on frugal innovation initiatives at work. The review of relevant literature yielded important parameters. The goal of this study was to establish an understanding of what frugal innovations mean to different researchers, and what characteristics are essential for launching and sustaining frugal innovations. The conclusions of this study have implications for academic research on frugal innovations and the frugal attitude, as well as for businesses seeking new ways to save money and expand their market opportunities while capturing an unserved market with frugal innovations. This paper examines the core characteristics of frugal innovation: Affordability, optimized for performance level, concentration on core functionality, simplicity, high quality, eco-friendly, and sustainability. The main research strategy used was the systematic literature review with some attention given to cases and practices based on the Sri Lankan context. The paper discusses different scenarios and cases guiding future research directions. It concludes research avenues by highlighting future research directions for extended studies.

Keywords: Core characteristics, Frugal Innovation Model, Sri Lanka, Affordability, Simplicity, Sustainability, Eco-friendly, Core functionality

1. Introduction

Due to resource constraints, the corporate world is becoming a more difficult place to work in, and the environments in which they operate are becoming more competitive, exacerbating the situation. Their

working conditions have grown more precarious, volatile, and ever-changing (Adelina & Sara, 2021). It is vital to keep up with the fast-paced world by exceeding customer expectations by doing more with less, all while remaining within ever-shrinking economic limits (Loukadounou, Koutsona, & Loukis, 2020). When resource constraints emerge, several approaches may be taken to solve them. Frugal innovation is a type of innovation that has occurred in underdeveloped nations. Frugal innovation (FI) has become the most often employed strategy in resource-constrained situations (Agarwal & Brem, 2018; Agarwal, Brem, & Dwivedi, 2019). Frugal ideas are especially popular in developing countries and markets at the bottom of the pyramid (Anderson & Markides, 2007; Imhof & Mahr, 2017; Prahalad, 2005). The benefit of cost-cutting technologies is that they may be utilized for more than simply pricing. Long-lasting and simple-to-use items are essential for frugal products.

Frugal innovation entails redesigning whole manufacturing methods and corporate structures, in addition to inventing goods (Knizkov & Arlinghaus, 2021; Radjou & Prabhu, 2015). Meeting the specified goal in acceptable quality and cost-effective ways is considered a frugal innovation. Also, frugal innovation may be thought of as a mentality or way of life (Balasopoulou et al., 2017; Gomera et al., 2020). Frugal innovation is defined as "a product, service, or solution that emerges despite financial, human, technological, and other resource constraints, and where the final result is less expensive than competitive offerings (if available) and meets the needs of customers who would otherwise go unmet" (Simula, Hossain, & Halme, 2015).

According to Farooq (2017), frugal innovation is a multifaceted construct with features such as cost, simplicity, quality, sustainability, resilience, management support, and defeaturing. Frugality, as described by Rao (2013), is functional, robust, user-friendly, growing, affordable, and local, and it is beginning to be applied to new business models. Frugality is not a new notion; it dates back to the mid-sixteenth century and is derived from the Latin word "frugalis" (frglis), which means thrifty and humble. This focuses on ensuring enough product quality, appropriateness, and portability while working with fewer resources (Herstatt & Tiwari, 2015). Frugality is defined by Lastovicka et al. (1999) as the extent to which consumers are both constrained in purchasing and resourcefully employing economic products and services to attain longer-term goals. Frugal refers to resource limits that result in significant resource savings (Rao, 2013). According to Levänen et al. (2016), there is a link between frugality and the features of a sustainable lifestyle, implying that the two phrases, frugality and sustainability are synonymous.

In a frugal culture, products should be of superior value, minimalistic in terms of resources utilized, and react to an urgent need to the point of altering lives, according to Radjou and Prabhu (2015). Furthermore, frugality focuses on maximizing consumption through improvements in the quality, affordability, and life of frugal things, as well as functioning in low-resource environments (Bas, 2016; Rao, 2013, 2017). Frugality broadens its scope to include the production of products in more cost-effective ways that satisfy the actual needs of potential customers, especially in growing markets (Horn & Brem, 2013). Furthermore, frugality encourages each feature and function to serve the goal of boosting the value and utility of a product for the user by providing a no-frills version that may be preferable to the standard offering (Rao, 2013).

These stripped-down versions increase usability while simultaneously saving money, resulting in a cost-effective solution. The wide and diversified market, as well as cost, are discussed by Bhatti and Ventresca (2013) as important factors in frugality. This market contains potential clients who want items but do not have a lot of money, therefore it is important to make them affordable. Frugal innovators, or entrepreneurs that focus on these frugal qualities, analyse people's hidden wants to create goods that meet those requirements (Radjou & Prabhu, 2015). Frugal innovations are products aimed at resource-strapped consumers that satisfy their fundamental needs at a minimal cost while still providing value (Zeschky, Widenmayer, & Gassmann, 2011). Frugal innovations are "products targeted at the resource-constraint

consumer meeting their basic needs, at a low cost but yet delivering value” (Zeschky et al., 2011). Thus, frugal innovations can benefit consumers in diversified ways.

1.1. Purpose of the Study

The purpose of this study is to consider adopting frugal innovation to unleash the market potential at the bottom of the pyramid market potential. This study looks at what is frugal innovation, and how it is similar to or differs from other types of innovations. This study explores what are the core attributes or characteristics of frugal innovations. Through a thorough frugal innovative literature review approach to understanding frugal innovation and research done and expand the horizons of harnessing the potential of an unserved market. In addition, this study extends the study of different use cases and the adoption of frugal innovation in the Sri Lankan context. In addition, this study adds to the existing knowledge base and offers suggestions for future research.

2. Methodology

The focus of this paper is on arguments and explanations that are primarily backed by empirical data and theoretical substance. The main research tool employed was a systematic literature review, which included reviewing research papers, journals, white papers, conference papers, and other industry publications to examine the principles and applications of frugal innovations. The present frameworks, theories, models, and associated future projects were then reviewed. Furthermore, the study aimed to address situations involving the use of core features, optimized performance level, simplicity, affordability, environmental friendliness, sustainability, and high-quality elements in frugal innovation. The paper emphasizes case and scenario data while paying special attention to the Sri Lankan context. This is a systematic literature review with theoretical and empirical evidence supporting the claims. Finally, the study concludes with an assessment of the instances and suggestions for future research possibilities based on the discussions.

The SPIDER tool (Sample, Phenomenon of Interest, Design, Evaluation, Research type) was utilized to design key parts of the search terms, as well as to educate and standardize the search process. The SPIDER tool is a better alternative to the more often used PICO (Population, Intervention, Comparison, Outcome) tool because it changes the PICO components to find qualitative research articles (Cooke, Smith, & Booth, 2012). Because 'Outcomes' (O) are more appropriate for qualitative research than 'Evaluation' (E), because they "may be unobservable, or subjective constructs (e.g., attitudes and perspectives), and so on (Cooke et al., 2012).

The SPIDER tool, as shown in Table 1, has been used for the search of research. The Sample, Phenomenon of Interest, Design, Evaluation, and Research type justifications are outlined in the given table. Based on the justification Table 2 outlines the SPIDER approach to the present study.

Table 1: SPIDER Tool

SPIDER	JUSTIFICATION
S – Sample	Smaller groups of participants tend to be used in qualitative research than quantitative research, so this term was deemed more appropriate.
PI - Phenomenon of Interest	Qualitative research aims to understand the how and why of certain behaviours, decisions and individual experiences. Therefore, an intervention / exposure per se is not always evident in qualitative research questions.

D - Design	The theoretical framework used in qualitative research will determine the research method that is used. As inferential statistics are not used in qualitative research, details of the study design will help to make decisions about the robustness of the study and analysis. In addition, this might increase the detection of qualitative studies in the databases in which titles and abstracts are unstructured.
E - Evaluation	Qualitative research has the same end result as quantitative research methods: outcome measures. These differ depending on the research question and might contain more unobservable and subjective constructs when compared to quantitative research (e.g., attitudes and views and so forth), so evaluation was deemed more suitable.
R - Research Type	Three research types could be searched for: qualitative, quantitative and mixed methods

Source: Cooke et al. (2012)

Because the study takes a qualitative approach, a systematic literature review was undertaken using the SPIDER method. As a result, the SPIDER approach was used in Table 2 in the present study. The following keywords specified in Figure 3 were utilized in the literature review search. Even though the following Table 3 specified search phrases were employed in various combinations to collect additional literature, quantitative and mixed method research articles were also retrieved to support the literature arguments. A substantial quantity of literature was discovered in the databases, and a subsequent review was undertaken based on that.

Table 2: SPIDER Approach to the Study

S - Sample	Decision Makers of Manufacturing Companies
PI - Phenomenon of Interest	Frugal Innovation
D - Design	questionnaire, survey, interview, focus group, case study, or observational study
E - Evaluation	Characteristics, awareness, views, attitudes, feelings, experiences, perception, beliefs, understanding, knowledge, opinion
R - Research Type	qualitative or mixed method

Source: Authors Work (2021)

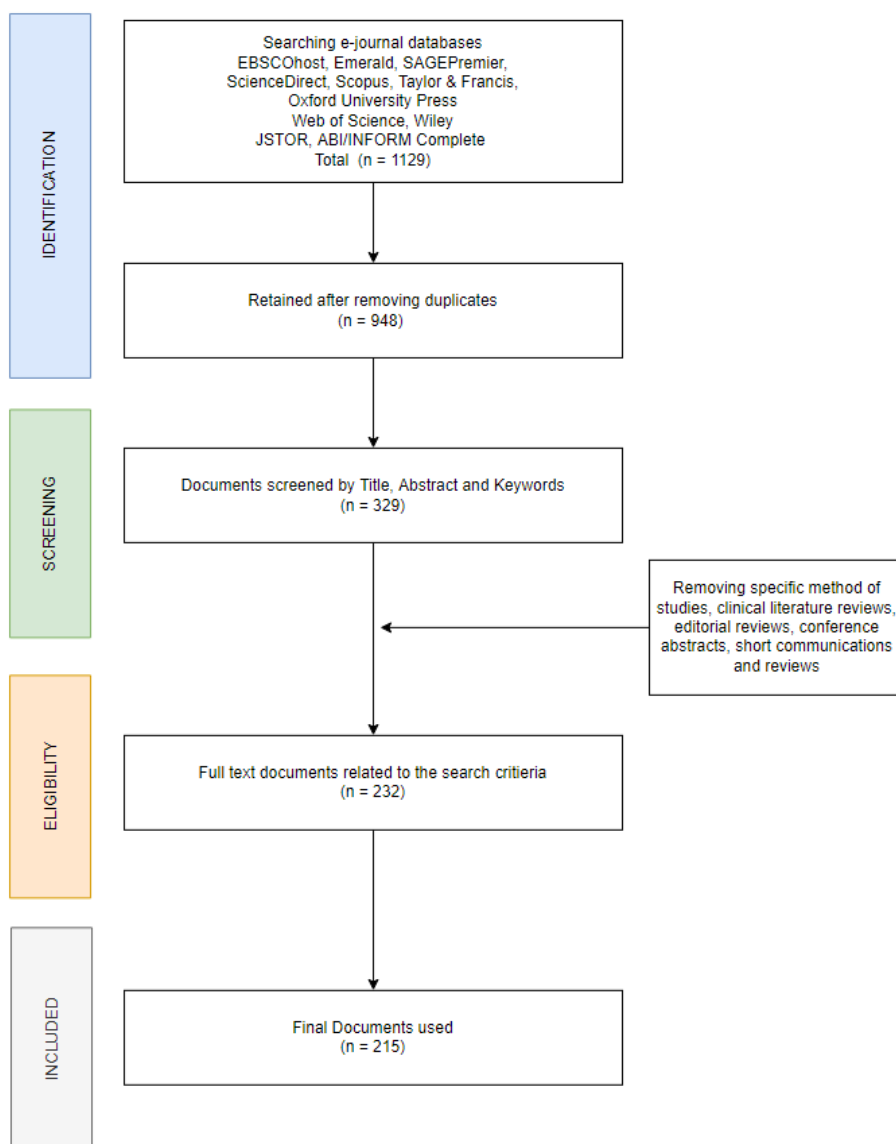
Table 3 : Search Terms

SPIDER	Search Terms
S	"manufacturing*" OR "production", "decision maker*" OR "leader*" OR "CEO" OR "director*" OR "CXO"
PI	"Frugal*", "Jugaad*", "Frugal innovation*", "Jugaad innovation*", "Catalytic innovation*", "Inclusive innovation", "Frugal engineering*", "Gandhian innovation*", "Resource-constrained innovation*", "Reverse innovation*", "Low-cost innovation*", "Cost innovation*", "Good-enough innovation*", "Grassroots innovation", "Constraint-based innovation*", "Bottom of the pyramid innovation*", ("frugal innovation*" AND "bottom of the pyramid*") OR ("frugal innovation*" AND "BOP*"), ("frugal innovation*" AND "emerging market*") OR ("frugal innovation*" AND "BOP*"),

	("frugal innovation*" AND "emerging econom*") OR ("frugal innovation*" AND "emerging market*")
D	"questionnaire*" OR "survey*" OR "interview*" OR "focus group*" OR "case stud*" OR "observ*"
E	"aware" OR "view*" OR "understand*" OR "experienc*" OR "opinion*" OR "attitude*" OR "perce*" OR "belie*" OR "feel*" OR "know*" OR "character*"
R	"qualitative" OR "mixed method*" OR "quantitative"

Source: Authors Work (2021)

Figure 1:
Screening Process



Source: Authors Work (2021)

A systematic literature review (SLR) was used in this study. The SLR aids in the resolution of several issues with the standard narrative literature review technique (Tranfield, Denyer, & Smart, 2013). A

systematic review is thorough, repeatable, and simple to utilize. The steps in the SLR method are as follows. Choose a research subject, develop a strategy, conduct a literature search, apply exclusion and inclusion criteria, assess quality, and synthesize the literature (Jesson, Matheson, & Lacey, 2011; Tranfield et al., 2013). We searched eleven major e-journal databases: EBSCOhost, Emerald, SAGE Premier, ScienceDirect, Scopus, Taylor & Francis, Oxford University Press, Web of Science, Wiley, JSTOR, and ABI/INFORM Complete to discover relevant information.

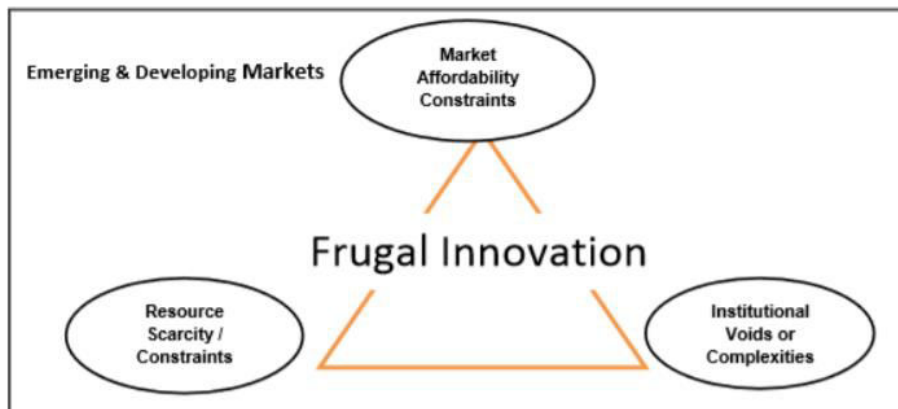
The full article search procedure is depicted in Figure 1. The 1,129 records were gathered from 11 different databases. A considerable number of records were found to be duplicated in other databases, thus 181 of them were eliminated. The number of publications was then decreased based on whether the term "frugal innovation" or a variation of it appeared in the title, abstract, or keyword list. There were 329 of these documents discovered. We eliminated 97 of the remaining 329 publications since they did not suit the study's objectives. We also looked at the abstracts and major bodies of the remaining articles to see if they focused on frugal innovation or used alternative vocabulary which led to the release of 17 more papers. The 215 papers were then posted to the Mendeley tool, a popular review platform.

The SPIDER instrument is frequently used in publications that use qualitative and mixed-method research. Because qualitative data is more detailed and complete, sample sizes in qualitative research are frequently smaller than in quantitative research. This study did a comprehensive review of the literature (SLR). The SLR method substitutes for several flaws in the traditional narrative literature review method. A systematic review is comprehensive, reproducible, and open to the public. The SLR method is broken down into the following steps: 1) Establish a research question. 2) Develop a plan, 3) conduct a literature search, 4) use criteria to select what to keep and what to eliminate, 5) evaluate the quality, and 6) summarize the results (Jesson et al., 2011). The SPIDER tool is used in research that takes a qualitative approach. Because the current study takes a qualitative approach, a systematic literature review was carried out using the SPIDER method to get additional information (Cooke et al., 2012).

3. Review of Literature

There are various dimensions or characteristics identified by previous researchers. Among them, Frugal Innovation Model was introduced by Bhatti and Ventresca (2013). In terms of frugality, Bhatti and Ventresca (2013) was the one to develop a model of frugal innovations (Figure 2). The model focuses on three characteristics that are important to grasp the concept of frugal innovation. The availability of many sorts of resources is limited in the first place. The limited purchasing power of the consumers also restricts activities. Emerging markets are the source of the second type of frugal innovation. Many people have unmet needs and limited financial resources to purchase products and services. Finally, a lack of institutions produces an environment in which the lines between formal and informal politics and conducting business blur. As a result, Bhatti and Ventresca (2013) defined frugal innovations as "the means and the ends to do more with less for more people".

Figure 2 :
Frugal Innovation Model



Source: Bhatti and Ventresca (2013)

The literature presently available studies frugal innovation under a variety of headings, including developmental economics, product and process engineering, sustainable business strategy, and mentality and attitude (Agnihotri, 2016; Balasopoulou et al., 2017; Prahalad, 2005; Prahalad, 2012; Prahalad & Hammond, 2002). There are different methods to display frugality, even though frugal innovations typically combine a frugal mentality, a frugal process, and a frugal outcome. A creator with little tools may employ a frugal approach to build beautiful furniture; an inventor of a scooter-mounted wheat mill has produced a frugal product, as has a rural housewife who wisely controls her money to buy groceries for her family (Krohn, Petersen, & Herstatt, 2019). Bound and Thornton (2012) defined frugal innovations as a unique innovation strategy that responds to resource constraints—financial, material, or institutional—and turns them into advantages. According to Pawlowski (2013), the goal of frugal innovation is to develop highly scalable solutions with core functionality at lower prices.

3.1 Frugal Innovations in the Sri Lankan Context

Sri Lanka is a lower-middle-income country with a diverse economy (Sakalasooriya, 2021). Sri Lankan frugal inventions have received limited attention in the literature. Despite being a developing country there is a lack of attention to detail when it comes to frugal innovation in Sri Lanka. On the other contrary, the literature suggests that economical concepts from other nations have been brought to Sri Lanka for application. Sri Lankan shoppers opt to use a variety of low-cost innovative things due to their affordability, simplicity, and value for money.

One of the frugal innovations that have taken attention in Sri Lanka is Pureit Classic. Pureit Classic by Hindustan Unilever is a water filter (HUL). Pureit is a gravity-driven "table-top" water filtering device that does not require power or flowing water to function. The water purification technology used meets the strict worldwide requirements for the elimination of harmful viruses and bacteria set by the US Environmental Protection Agency. Bangladesh, Brazil, Indonesia, Mexico, Nigeria, and Sri Lanka now have access to the filter. Pureit's success was partly due to its low cost, with the device costing less than half of competing purifiers at the entry-level, and the firm investing considerably in R&D (Levänen et al., 2016). Tata Motors Limited (TML), the publicly traded Tata Group corporation famous for introducing the world's cheapest vehicle, "Tata Nano," has another successful, frugal innovation, a tiny truck "Tata Ace," which debuted in May 2005. It is well known for its success. The Tata Ace is a compact, pay-loaded commercial truck weighing 0.75 tons (SCV). The Ace is half the price of any other four-wheeled commercial vehicle in India, with a starting price of approximately \$5,000. This vehicle contains all of the essential qualities and is both inexpensive and long-lasting. Sri Lanka was the first market in the world to import Tata Ace, which was sold under the brand name "DIMO Batta".

Another inexpensive and smart concept is the Sustainable Water Supply Solution. A project was carried out to apply a frugal innovation strategy to provide a sustainable and accessible water supply for drinking and irrigation in Sri Lankan refugee villages to increase agricultural production. Balasundaram (2015) highlighted possible frugal innovation areas. Among the categories are aquifer identification, low-cost well drilling, low-cost irrigation, and efficient transportation. The objective was to develop a system that was both inexpensive and efficient. The emphasis was on creating cost-effective, efficient solutions as well as reinventing existing business models (Balasundaram, 2015).

3.2 Frugal Mindset

The essential concepts of mindsets and the decision-making process must be mastered to fully learn the required frugal mentality. The first step in capitalizing on frugal innovation opportunities is to identify them inside the organization. It is crucial to remember that it is the individuals inside the firm that identifies or overlook chances for growth, not the company itself (Krohn, Petersen, Hochmuth, & Herstatt, 2020; Soni & Krishnan, 2014). Individual behaviour is commonly linked to a person's thinking, and mindset theories are becoming more popular as predictors of organizational success (French, 2006). As a result, attitudes in organizations are critical for both individual behaviour and broader company behaviour. Such a mindset is marked by resilience, frugality, adaptability, simplicity, inclusivity, and compassion, according to Radjou, Prabhu and Ahuja (2012).

To obtain a thorough understanding of the crucial frugal mentality, you must first learn about mindsets and how individuals make decisions. The first step in utilizing frugal innovation possibilities within a company is to locate them. In this way, keep in mind that it is the people in the company, not the company itself, who recognize or overlook development potential. People's behaviours are frequently tied to their thoughts, and mindset theories are becoming increasingly prevalent as indicators of an organization's success. As a result, organizational attitudes have a significant effect on how people and the company behave (Othman, Kineber, Oke, Zayed, & Buniya, 2020). The early twentieth-century work of the Würzburg School of Cognitive Psychology forms the foundation for a well-known and commonly used line of mindset study. The action phases mentality explains how people make decisions and how those decisions lead to actions (Mourtzis, Vlachou, Boli, Graviyas, & Giannoulis, 2016).

According to cognitive psychology studies, depending on the job at hand, different mindsets are engaged. Gollwitzer's theory examines the process of action in depth and divides it into phases based on distinct mindsets. As a result, Gollwitzer's paradigm is the greatest approach to properly comprehending how people make decisions in businesses, and scholars in subjects like behavioural psychology and organizational management utilize it often (Cappelli, Singh, Singh, & Useem, 2010). The actions phase model categorizes behaviour into four distinct stages. Each stage has its mindset, such as a deliberative mindset in the pre-decisional and post-national phases, and an implemental mindset in the practical and actional phases. According to Agarwal et al. (2017), a person's mentality is a cognitive orientation that facilitates task completion, and the mentalities of the various phases are applied in the correct sequence (Mourtzis, Vlachou, Boli, et al., 2016). The objective of this study is to investigate the pre-decisional stage and the deliberate frugal attitude that arises when developing the execution goal of a frugal innovation project. This is being done to get a better understanding of how individuals decide to launch or support frugal innovation efforts in their firms, as well as how they capitalize on frugal innovation opportunities (Cappelli et al., 2010; Mourtzis, Vlachou, Boli, et al., 2016).

According to the definition, the deliberate frugal mindset is a cognitive orientation characterized by the belief that offering innovations with optimized performance levels, a focus on core functionalities, and significant cost reductions offer viable business opportunities, and that the individual and organization are

capable of developing these frugal solutions successfully. Declaring a (goal) intention is the final and most important phase in the decision-making process.

3.3 Frugal Innovations Comparison with Other Innovation Concepts

Emerging markets provided the most innovative ways to save money. The key goal was to provide services and products that met the requirements and expectations of these markets while remaining accessible to those with limited financial resources. Simultaneously, cost-cutting inventions have seeped into established markets, a phenomenon known as reverse innovation. There have been several articles written regarding innovative methods to save money. Agarwal et al. (2017), for example, present 30 distinct low-cost technologies. The Tata Nano and the GE Vscan are two well-known ultrasound machines that fit in the palm of your hand. But, exactly, what does it mean to be resourceful with money? What distinguishes frugal innovation from other methods of generating new ideas? These definitions are based on what is meant by frugal innovation (for instance, low impact on the environment, limited features, ease of use and significantly lower costs). Other articles employ concepts such as Gandhian innovation, good-enough innovation, reverse innovation, frugal engineering, jugaad innovation, low-cost innovation, and constraint-based innovation to demonstrate how to find cheap inventions (Dhraief et al., 2018). The frameworks and terminology we use currently assist us in comprehending the potential of frugal innovation. However, there are currently no clear guidelines for defining frugal innovation (Cappelli et al., 2010).

According to Bahadur & Doczi (2016), most aspects of frugal innovation may be classified into three categories: degree of performance, core functionality, and cost reduction. Based on this finding they developed three conditions for economic innovation: a large decrease in expenditures, a focus on only the necessary activities, and an ideal level of performance (Bahadur & Doczi, 2016). If an invention fits all three criteria at the same time it should be dubbed frugal. These three requirements offer a more complete picture of how economic innovation works (Dhraief et al., 2018). For instance, all three requirements must be met at the same time, which may be tough. This has practical implications: while creating cost-cutting innovations, it is vital to analyse all three aspects to establish precisely what makes a new product or service less expensive. Agarwal et al. (2017) use terminology like indigenous innovation, Gandhian innovation, reverse innovation, jugaad innovation, grassroots innovation, catalytic innovation, and constraint-based innovation to distinguish frugal innovation from similar concepts (Bahadur & Doczi, 2016).

Individuals must find creative solutions when there is a lack of money or natural resources. Frugal innovation is a relatively new sort of invention, yet it is gaining popularity (Höfling, 2015). To be financially self-sufficient, one must be both resourceful and thrifty. In the 1600s, frugality meant being austere, modest, and resourceful. Frugal innovation, in general, refers to services and items that are always being created and improved for their essential functions. This technique allows for lower retail expenses and gives economic opportunities to groups that previously did not have them (Cappelli et al., 2010). Bahadur and Doczi (2016) developed a definition that they feel will be valuable to future researchers. According to the literature, frugal innovation in the context of the bottom of the pyramid (BoP) is defined as affordable and modest inventions that serve Bottom of the Pyramid (BoP) clients (Bahadur & Doczi, 2016).

Table 4 : Attributes and characteristics of frugal innovation

Attribute categories (first-cycle coding)	Attributes and characterisations of frugal innovations used in articles ^a
Functional and focussed on essentials	Bare essentials, core benefits, cut corners, taking exception to some of the requirements, de-featuring, eliminating unessential functions, entirely new applications, provide the essential functions people need, fulfil the requirements of awareness, fulfil the requirements of availability, good enough, light, limited features, new functionality, do not have sophisticated technological features, portability, reduced functionalities, reducing the complexity, tailor made, unnecessary frills stripped out
Considerably lower initial cost or purchase price	Accessible, affordable, affordability, avoid needless costs in the first place, cheaper, cost discipline, cost effective, extreme cost advantage, fulfil the requirements of access, fulfil the requirements of affordability, low budget, low cost, low prices, low priced, minimising non-essential costs, minimum cost, more affordable prices, much lower price, reducing cost, trying to reduce the cost, significantly lower costs, ultra-low cost
Reducing the total cost of ownership	Reducing the cost of ownership
Minimising the use of material and financial resources	Avoiding obesity, draw sparingly on raw materials, economical means, economic use of resources, low input of resources, minimise the use of extensive resources, minimise the use of financial resources, minimise the use of material, reduces material use, reducing the use of scarce resources, resource-saving product
User-friendly and easy to use	Easy to use, simple, simpler
Robust	Durable, low maintenance, reliable, robust, robustness, stable, sturdy, tough
High value and quality	Fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards, good service, high-end technology, high value, leapfrog technology, maintain quality, maximising value, right value proposition, value for money, value products
Scalable and sales of large numbers	Drive profits through volumes, highly scalable, mega-scale production, scalable
Sustainable	Eco-friendly, ecological, little environmental intervention, low carbon footprint, meets green marketing objectives, service ecosystem, sustainability

Source: Weyrauch and Herstatt (2016)

Table 5: Frugal Innovation Definitions

Definition	Substantial cost-reduction	Optimal performance level	Focus on core functionalities	Studies
"We have adopted the term frugal innovation, defined as responding to severe resource constraints with products having extreme cost advantages compared to existing solutions" (p. 39)	x			Zechky, Widenmayer & Gassmann (2011)
"Ability to generate considerably more business and social value while significantly reducing the use of scarce resources" (p. 1)	x			Radjou & Prabhu (2013)
"Frugal innovation is a term that has been used to describe the low-cost products and services, as well as the systems and processes adopted by organizations to develop them." (p.4)	x			Ojha (2014)
"An appealing solution to this dilemma is the use of frugal-innovations with cutting edge technology to create low-cost products. The adoption of frugality entails design principles that advocate minimal use of re- sources for realizing efficient functioning of products" (p. 66)	x	x		Rao (2013)
"Frugal innovations in products are vital in developing countries to reach price sensitive customers that seek robust products at low prices" (p. 3309)	x	x		Prabhu & Gupta (2014)
"Frugal innovations combine low-cost solutions, low-cost manufacturing and low-cost materials with design that focuses on basic functionality and minimal feature sets. In this context, the key words are resource scarcity, simplification, environmentally sustainable and lean practices." (p. 1568)	x		x	Simula, Hossain & Halme (2015)
"Frugal innovation is about creating highly scalable products which have reduced functionalities while reducing costs" (p. 527)	x		x	Pawlowski (2013)
"Seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) with the objective of reducing the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards" (p. 98)	x	x	x	Tiwari & Herstatt (2012)
"Frugal innovation mostly occurs within the three main categories cost reduction, functionality, and performance level." (p. 6)	x	x	x	Weyrauch & Herstatt (2016)

Source : Weyrauch and Herstatt (2016)

Table 6: Frugal innovation and related concepts



Source: Costa (2018)

Only one of the three criteria proposed by Weyrauch and Herstatt (2016), affordability or considerable cost reduction, is shared by grassroots innovation. Except for reverse innovation, the others have two characteristics. Jugaad innovation differs from frugal innovation in that it is not acknowledged for obtaining the maximum level of performance, whereas Gandhian, Indigenous, and Catalytic innovations are not concerned with core features. Furthermore, Brem and Wolfram (2014) point out that Jugaad's ideas are extremely unique since they start with a problem rather than the primary product. Other academics have added a few conditions to the Jugaad notion. As a result, Jugaad innovation is built on a more improvised approach to everyday challenges, that is "making do with what one has" (Sinha, 2013). In addition, jugaad ideas are unlikely to be financially feasible or widely accepted across cultures (Agnihotri, 2016). The three fundamental requirements for frugal innovation are contained in reverse innovation. This occurs because reverse innovation refers to frugal ideas that originate in emerging countries and are later popularized in mature economies (Ahuja, 2021; Brem & Ivens, 2013; Horn & Brem, 2013). Renault-Logan (a low-cost automobile model) is an example of reverse innovation since it was initially popularized in underdeveloped regions and afterwards in rich nations. When we consider another possible aspect of innovation, scalability, we see that grassroots and Gandhian inventions only expand inside the local context, whereas Jugaad and Indigenous ideas extend over the local context, but only on a limited scale. Catalytic and Frugal, on the other hand, disseminate globally.

Jugaad innovation varies from frugal innovation in that it sacrifices quality, provides a temporary solution, and is not widely adopted (Abrol & Gupta, 2014). Although Gandhian innovation is focused on quality and takes advantage of this by utilizing current technologies (technology-driven innovation), this form of constraint-based innovation is only seen in a local setting (Prahalad & Mashelkar, 2010). Because of its increased scalability, catalytic innovation focuses on social transformation, and even if the goods are of inferior quality, they are still regarded as "good enough" (Christensen, 2006). This is in contrast to frugal

innovation, which is characterized by "meeting or even exceeding established quality criteria" (Herstatt & Tiwari, 2017). To distinguish frugal from grassroots or indigenous innovation, we can say that grassroots innovations are environmentally focused; additionally, indigenous innovation employs know-how from developed nations to improve capacities in developing countries, whereas frugal innovation uses the reverse flow of information (Serger & Breidne, 2007).

Table 7: Concept matrix sharing common characteristics with frugal innovation

	Frugal innovation – three main criteria			Scalability		
	Substantial cost-reduction	Optimal performance level	Focus on core functionalities	Local context	Small diffusion	Diffusion
Grassroots innovation	x			x		
Jugaad innovation	x		x		x	
Gandhian innovation	x	x		x		
Indigenous innovation	x	x			x	
Catalytic innovation	x		x			x
Frugal innovation	x	x	x			x
Reverse innovation	x	x	x			x

Source: Costa (2018)

3.4 Characteristics of Frugal Innovation

The definition of frugal innovation is supported by several sources in the literature. Ruggedization, performance level, cost reduction, user-centered design, core functionality, environmental concerns, and a no-frills approach were the seven traits that came from Bahadur and Doczi after a comprehensive examination (Bahadur & Doczi, 2016). The preceding characteristics can be regarded as economical, modest, and inexpensive depending on how we use and interpret the word frugal. In this scenario, we would like to concentrate on environmental concerns. As previously stated, FIs tend to utilize fewer resources during various periods of their life cycle, such as while acquiring resources, utilizing goods, and planning for the end of life. As a result, one may argue that low-cost innovation can help products achieve higher ranks in sustainability rankings (Cappelli et al., 2010).

The study results of Hatch and Schultz (2008) show that clever inventions do not always solve environmental problems right away, but they can. When resources are limited in how products are made and how they are used, it helps the environment in a way that is not always obvious (Hatch & Schultz, 2008). This idea disproves the common belief that FI does not care much about sustainability. Statistics show that performance level, functionality and cost reduction are the most talked about topics in frugal innovation (Mourtzis, Vlachou, Boli, et al., 2016). The most important element is cost reduction, which includes a much lower purchase price or initial cost, a lower total cost of ownership, and the most effective use of financial and material resources. Mostly the terms "vastly decreased price", "far lower expenditures" and "ultra-low cost" were employed. So, the first thing we look for in a frugal innovation is a big cost reduction, which we will go over in detail in the following section (Bahadur & Doczi, 2016). The essential functioning category is the second most significant. It has characteristics such as function and a concentration on the essentials, minimizes the use of financial and material resources, and is straightforward and easy to understand (Cappelli et al., 2010). According to the research, this includes things such as core benefits, constrained functioning, and important functions that people require. As a result, the focus on basic functionality is the second need for low-cost innovation (Höfling, 2015).

The third crucial category is performance level. This topic covers a wide range of issues of economic innovation. Economical innovation is defined by phrases such as dependable, high-end technology, resilient, quality maintenance, ease of use, and exceeding or meeting specific specified criteria for acceptable quality standards. Simultaneously, low-cost innovations must address highly particular demands that are typically not fulfilled by by-products in the mature market. As a result, our third criterion for frugal innovation will be to maximize performance (Hatch & Schultz, 2008). All cost-cutting innovations have one feature; they all fulfil all three requirements at the same time. However, how the three criteria described above in real products and services are heavily influenced by the user's surroundings and circumstances. Even though criteria 2 is the same for emerging and developed markets, the most significant functions will vary based on the circumstances (Cappelli et al., 2010). Other types of fresh ideas can be evaluated using the same three criteria. Cost innovation is distinct from other forms of innovation in that it focuses on drastically lowering costs. The fact that frugal innovation must achieve all three requirements at the same time sets it apart from other forms of innovation (Bahadur & Doczi, 2016).

3.4.1 Substantial Cost Reduction / Affordability

A significant cost reduction is required for frugal innovation to succeed. Frugal innovations are significantly cheaper or have substantially lower pricing when compared to standard goods and services. The findings demonstrate that this feature is emphasized in practically every explanation or definition of frugal innovation. Literature is divided on whether reduced costs must always be from the perspective of the consumer or if an innovation may be deemed frugal even if the lower costs are primarily from the perspective of the service provider or manufacturer (Cappelli et al., 2010).

Data analysis should always be done from the client's perspective. According to the literature study, the majority of the phrases used to describe the product are oriented toward the client, such as affordable, low budget, and low cost. A cost decrease that only affects one manufacturer or service provider is unsatisfactory since it does not correspond to much of the vocabulary used to describe economic innovation (Bahadur & Doczi, 2016). Finally, it is always critical to provide the customer with what they want, which is a considerable cost decrease. The service provider's or manufacturer's point of view is already provided. According to a few publications, the goal of frugal innovation is to minimize the total cost of ownership. This is at least true for the Indian market. This notion is supported by the significant cost reduction criteria, which encompasses a reduced total cost of ownership as well as a lower purchase price. A minimum of one of the two requirements must be satisfied (Bahadur & Doczi, 2016). Frugality requires a wide and diverse market as well as affordability (Bhatti & Ventresca, 2013).

3.4.2 Concentration on core functionalities

The emphasis on what is most essential is the second requirement for frugal innovation. The majority of the time, research ties low-cost innovation to core advantages, critical functions, and reduced complexity. As a result, frugal innovation must concentrate on the essential characteristics that provide the most value to customers. It must also directly meet user requirements (Bahadur & Doczi, 2016). The majority believe that inexpensive inventions save money and time while being simple to comprehend and utilize. It's more than simply a money-saving strategy to concentrate on core competencies. Streamlining a product or service places the most crucial components at the forefront. This can make it easier to use, conserve resources, have a smaller influence on customer behaviour, or match a particular lifestyle or environment (Cappelli et al., 2010). As a result, the criteria emphasis on critical competencies is a separate criterion that encompasses all of the aforementioned descriptions.

Cost-effective innovations must emphasize necessary functionality above established market alternatives. There is a desire for well-built yet simple-to-use devices, free of all unnecessary gadgets and capabilities

that 99 percent of consumers never use. Simpler things may be sold at lower prices without sacrificing profit margins. Furthermore, simple and strong items last longer, need less maintenance and have fewer flaws. Customers on a tight budget may be willing to learn more about such "sensitive" things. This may encourage sellers to reveal additional information about less obvious items, such as life expectancy, the total cost of a life cycle, and total ownership expenditures. When more individuals are frugal, what they see and buy in a store might drastically change (Krohn et al., 2020; Muradian, 2019; Wierenga, 2015).

3.4.3 Optimized for Performance Level

It is essential for understanding the complete spectrum of frugal innovation. Simply focusing on core functions is insufficient. A thorough examination of the required standards of quality and performance is also required. All engineering and functional properties, such as precision, durability, power and speed are included in this definition of performance (Akbar & Subramaniam, 2019). The primary technical criteria must be satisfied depending on the scenario to identify the level of performance change. A low-cost automobile is not the same as low-cost ultrasound equipment in terms of engineering. All innovations, not only cheap ones, must be thoroughly examined to determine their viability (Bahadur & Doczi, 2016).

In the case of low-cost technological items, both high-end and low-cost, frugal innovations are stated to be performing as intended by their creators. As a result, the required level of performance and quality must be fulfilled (Bahadur & Doczi, 2016). This is an area where Agarwal et al. (2017) place a lot of emphases: achieving the specified goal using appropriate, cost-effective processes. Low-cost innovations also meet or surpass predetermined requirements and acknowledged quality standards. As a result, cost-effective innovation should satisfy the required levels of performance and quality while keeping expenses to a minimum (Albert, 2019).

3.4.4. Ease of Use / Simplicity

It is considered that for frugal innovation, resources are used in a more economical, frugal, limited, and productive way, that they are maintained, saved, reduced, underutilized, and minimized, as well as local resources and more sustainable. Resourceful innovation improves and makes energy and material efficiency as excellent as possible (Tiwari & Herstatt, 2013). Some argue that sufficiency and replacement are key components of environmental sustainability. Furthermore, frugal innovation creates value from waste, reuses existing materials and parts, recycles rather than acquiring new ones, and extends the functional life of its products by making them modular and easy to fix (Hindocha, Antonacci, Barlow, & Harris, 2021). According to some researchers, frugal innovation seems to have little environmental impact which was contradicting many researchers, leaving a decreased ecological or carbon footprint (Albert, 2019). Environmental sustainability and frugal innovation complement each other for a variety of reasons, including the innovations' cheap cost, lowered complexity, limited resource use, simplicity, no-frills design, and durability (Mukerjee, 2012).

3.4.5 High Quality

In frugal innovations, the quality aspect of the product or service is a key concern. Products of high quality and few resources should be used in their frugal context and must answer to an urgent need in a way that changes lives, according to Radjou and Prabhu (2015). Colledani et al. (2016) have recognized five primary avenues as effective levers for generating frugal products for specific markets with favourable cost and quality we are creating new products from scratch in local R&D centres; adapting existing solutions for local markets by using less expensive but functional materials; reducing unnecessary product and service features from existing products and services; and recreating. Most frugal innovations keep high quality as a major factor. Both Narayana Hrudayalaya and Aravind Eye Care System are well-researched, effective approaches for providing accessible frugal healthcare. Both companies produce enough money to

support their rapid development and expansion while providing high-volume, high-quality medical treatment to the general public using relevant and effective technology. India is the preferred first-launch market and comes in second only to the United States in terms of the number of frugal healthcare product breakthroughs. One of the many famous inexpensive medical inventions from India is the Jaipur foot (Balasopoulou et al., 2017). In addition to price, consumers need value-adding product characteristics like quality and robustness (Sharmelly & Ray, 2018). Utilizing the idea of smart resource management, frugal innovation creates products with the best possible cost and quality for specific markets (Mourtzis, Vlachou, Giannoulis, Siganakakis, & Zogopoulos, 2016).

3.4.6 Sustainability

The United Nations World Summit on Sustainable Development defined sustainable development as three interconnected and mutually beneficial pillars: social development, environmental protection, and economic development (Mourtzis, Vlachou, Boli, et al., 2016). As a result, sustainable development is a process of growth and advancement that strives to balance economic, social, and environmental factors to ensure long-term existence. People generally believe that economic, social, and environmental issues must be balanced for sustainable development to occur (Albert, 2019). Others claim that FI has no long-term effects, does not always support sustainability, and is not always helpful to the environment at first. According to several scholars, companies need to modify business models, restructure value chains, create a new market, and employ a strategy that can be scaled up and sustained over time (Hindochoa et al., 2021).” A company's sustainability performance might be improved via frugal innovation (Brem & Ivens, 2013; Khan, 2016). The number of resources and materials needed for their operations, the way products are manufactured and packaged, and how consumers are involved are now being questioned by businesses. Several companies have embraced engineering and economic sustainability as a core notion for their company plans (Prabhu, 2017; Radjou & Prabhu, 2015; Santos, Borini, & Oliveira Júnior, 2020). Sustainability is a major factor when it comes to being frugal. The goal of sustainability is to create settings, products, or processes that are high-quality while using minimal resources (Prime et al., 2018).

3.4.7 Eco-friendly

According to several scholars, frugal innovation is an inherently green, ecological, eco-friendly, or environmental, the best model for making green products with little or no environmental intervention, that addresses environmental constraints, solves ecological sustainability needs, can support environmental goals, is part of an ecological concept, and has ecological aspects as direct attributes (Tiwari & Herstatt, 2012). They are also said to be more climate-friendly, protect the integrity of the planet's environment, improve green supply chain initiatives, meet green marketing goals, have fewer negative external effects, and improve a company's sustainability management in terms of outcomes, value activities, and input resources (Mourtzis, Vlachou, Boli, et al., 2016).

Various studies and papers have described frugal innovation in different ways, but they all agree on the following characteristics:

- Concentrating on the most basic requirements or the core requirements
- Eliminating non-essential product functionality.
- Reducing the number of steps (e.g., service processes or manufacturing processes).
- Uncomplicated (No-frills).
- A simple design.
- Simple / Easy to use but robust.
- Being conservative with resources.
- Getting more done with less. 9. Cost-cutting measures.

(Kuo & Ng, 2016).

4. Limitations and Further Research

What we can accomplish with our inquiry has limitations. To begin with, research on ways to enhance the economy is still in its infancy. There have been a few scholarly studies concerning frugal innovations, but the number is expanding. Second, we needed to devise criteria for selecting publications (Knizkov & Arlinghaus, 2021). A specific keyword search can result in the omission of certain well-known works from the literature review. Last but not least, the concept of frugal innovation is still being developed. On the one hand, determining what makes an innovation inexpensive may limit the scope of the current discussion (Cappelli et al., 2010). There is still more research to be done. First, frugal innovation characteristics may help determine the most critical factors to consider while developing a frugal product. Making frugal innovations, on the other hand, is difficult, especially for companies that have been around for a while (Bahadur & Doczi, 2016). Researchers should investigate ways to create cost-effective breakthroughs. Second, we must consider the issues that may arise while attempting to be innovative in business. Third, little is known about the role of low-cost products and services in emerging economies. More study is needed to determine which organizations and categories of individuals will benefit the most from cost-cutting technology (Cappelli et al., 2010).

5. Conclusion

This systematic review demonstrates the utility of the SPIDER search strategy tool. The investigation of frugal innovations is still in its infancy. The majority of the literature on frugal innovation has been focused on developing markets. However, in markets that are already performing well, growing and changing are also employed. As a result, a precise definition of the term frugal innovation is critical. It would be beneficial to agree on a set of criteria that must be completed for a concept to be called frugal. With this purpose in mind, we investigated the definition of frugal innovation. According to our findings, most of the characteristics and attributes of frugal innovations fall under affordability, sustainability, core functionality, optimized for performance level, high quality, eco-friendly, and simplicity. We believe that this helps us better grasp the essence of frugal innovation, allowing us to better satisfy the demands of emerging markets while also transferring and adapting the basic idea to established markets. Organizations may use the identified contributing attributes in the frugal innovation building process to enable and encourage frugal innovation initiatives that benefit society. The findings may be utilized to encourage individuals to adopt a frugal attitude and make it simpler for frugal innovation ventures to succeed.

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